Sensation, Attention and Perception

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B. Sensation

B.1 What is sensation?

Sensation is the process by which the sense organs, such as the eyes and ears, gather information about the environment. Our senses include vision, hearing, smell, taste and skin senses. The study of sensation is related to the initial contact between organism and the physical environment focusing on different forms of sensory stimulation (example: electro-magnetic pressure, sound-waves) and the input registration by the sense organs (e.g. the eyes, ears, nose, tongue and skin). The relationship between various forms of sensory stimulation (electro-magnetic, pressure, sound waves) and their registration by sense organs (eyes, tongue, skin, ears) is the process of sensation.

This definition of sensation has the following components:

I. involvement of sense organs of the organism.
II. presence of stimulus in the physical environment
III. constructing knowledge out of raw material and
IV. initial contact i.e. contact without meaning

B.2 How is sensation different from Perception?

Perception is the process through which we interpret and organise the received information so as to produce our conscious experience of objects and their relationship.

In this process physical energy; such as light, sound waves, heat; emanating from objects is transformed by the concerned sense organs into a code and transferred to and interpreted by the brain. The line between the two terms sensation and perception, therefore, is somewhat arbitrary. Sensation typically refers to the direct reception and transmission of messages, whereas perception refers to the active process of integrating and organising these sensations.

Perception is an active process with perceptual selectivity and perceptual constancy. Perceptual selectivity will include attention, perceptual set, perceptual accentuation and perceptual constancy will have some details of size, shape, colour and brightness constancies.

B.3 Human Senses and Physical Energy

Our sense-organs-eyes, ears, skin, nose and tongue – provide sensations of vision, hearing, skin senses, smell and taste. Physical energy emanates from objects such as light, sound waves, heat and touch. These physical energies provide different types of sensations when presented as stimuli.

You have known here two things, that is (i) Our senses include vision, hearing, skin senses, smell and taste. (ii) Physical energies emanates from objects such as light, sound waves, heat and touch. In the absence of physical energies as stimuli, sensation normally does not take place.

B.4 Process of sensation

Physical energy, such as light, sound waves, heat; emanating from objects becomes stimuli and is received by concerned sense organs like eyes, ears, and elsewhere through specialized receptor cells. The energy is next converted into electrical impulses and this process is known as transduction – i.e. translation of a physical energy into electrical impulses by specialised receptor.

The electrical impulses then travel from the sense organs along nerve fibers to the central nervous system and finally to appropriate area of the cerebral cortex. The process of sensation includes the direct reception and transmission of messages to cerebral cortex.

B.5 Concepts of Thresholds

Two of the fundamental questions that psychologists studying sensation strive to answer are: Exactly how does transduction take place in each of the sensory systems? How do the sensory systems and the brain distinguish between the different types of stimuli in the environment? In addition to responding to a particular type of stimulus, each sensory system is responsive to two important properties of stimuli: quality and quantity. The quality of a stimulus refers to the kind of stimulation produced; for instance, the color of a light. Quantity refers to the amount of stimulation-how intense or bright the light is, for example.

Closely related to the concept of quantity is the idea of sensory thresholds. Absolute threshold refers to the quantity of stimulation necessary for an organism to sense a stimulus. Difference between two stimuli that is necessary for humans to tell the two stimuli apart is called difference thresholds.

B.6 Absolute Threshold

The world around you provides many stimuli at a time but you do not respond to all stimuli, particularly those which are very low in intensity. Different types of sensations need different intensity of stimuli for activation. We can smell a single drop of perfume in an empty three-room apartment and on a clear dark night, we can see a dim candle thirty miles away. A question arises then that how much physical stimulation is necessary in order to experience a sensation? Normally we think that the relationship between stimulus intensity and sensation is direct, meaning that we always will have sensation when the intensity of stimulus is sufficient. But in a real life it does not happen.

One reason may be that our sensitivity to external stimuli changes from moment to moment and in order to maintain the body's internal environment at optimal level the sensitivity of our sensory organs to stimuli varies. The sensory system will not respond unless the stimulus energy is above some critical level of intensity, the so-called absolute threshold.

Absolute threshold, therefore, is the smallest amount of a stimulus that one can detect 50% of the time.

Suppose one stimulus is presented to a person and of total number of trials the person is able to detect the stimulus 50% of the time, this point of detection is known as absolute threshold. This way, absolute threshold is the point where a person is able to detect the presence of the stimulus half of the times the stimulus is presented to the person.

However, the **absolute threshold** is not a constant value but changes from person to person and from situation to situation. The absolute thresholds for our senses are surprisingly low. For example, we can see a candle 30 miles away on a dark, clear night, and we can detect a single drop of perfume in a six-room apartment (Galanter, 1962).

As you may have gathered, the term absolute threshold is somewhat misleading. There is no single or absolute intensity at which a subject will detect a light on every trail. Notice that the subject was able to detect the light when it was set at eight units 75 percent of the time. The subject could detect the light at five units 50 percent of the time. And when the brightness was set at three units, the subject detected it only 25 percent of the time. Thus, the amount of stimulation necessary for detection changes from trail to trial. Because it is impossible to pinpoint the exact threshold, psychologists have agreed on the rather arbitrary definition of the point at which the subject can detect the stimulus 50 percent of the time.

You can appreciate firsthand how a threshold changes from trial by trying the following demonstration. You will need a wristwatch or alarm clock that ticks. Place the clock on a table in a quiet room and move across the room until you can no longer hear the ticking. Now approach the clock one small step at a time. Mark the point at which you hear the ticking. Repeat this procedure 10 times, each time marking the point where you first heard the ticking. You will probably notice that you threshold for hearing the clock was slightly different on each trail.

Psychologists have now identified several factors that help to explain why thresholds may vary at different times. One of the factors that can effect threshold is the number of sensations competing for our attention. In the laboratory, researcher try to eliminate other, distracting stimuli, but in real life this is rarely possible. You have probably experienced this yourself if you tried to hear a clock ticking in a busy office. **Noise** in the term used to define irrelevant and distracting stimuli. Noise need not refer only to auditory stimuli. It can affect the other senses as well, such as when you try to find the Big Dipper while standing on a brightly lit city street.

Another factor affecting threshold in the subject's motivation. For example, if subjects are told that they will receive a dollar each time they detect a light, they might be willing to adopt a lower threshold for detection. That is, they might say they see the light even if they are not entirely sure. On the other hand, if the subjects are told they will have to pay a dollar each time they give a wrong answer, they will probably raise their threshold to the point where they are absolutely sure they see the light. Similarly, a young child might have a higher threshold for pain from a stomach ache when it's time to go out to play than when it's time to go to school.

B.7 Difference Thresholds

Another point is important in sensation as to how one discriminates between two sensations. What is the minimal amount by which original intensity of a stimulus is increased so that it may have a changed sensation? Consider the sensation of visual brightness produced by a patch of light on the eye. To experience a sensation of brightness just greater than the previous one, how much minimal amount of light intensity patch is to be increased. Again, the changed brightness must be experienced by 50% of the times of presentation.

This amount which makes a difference is called difference threshold. It produces a just noticeable difference, that is j.n.d. The j.n.d. indicates subject's capacity to discriminate.

The **difference threshold** is the amount by which a given stimulus must be increased or decreased so that the subject can perceive a just noticeable difference (j.n.d.) 50% of the times.

Perhaps the most important finding regarding the difference threshold is that, like the absolute threshold, it is not constant. As Ernst Weber first discovered in the mid 1800s, humans are able to perceive small changes if the reference stimulus is small, but as the reference stimulus grows larger, a greater change is necessary before the subject perceives a difference.

B.8 PSYCHOPHYSICAL METHODS

The set of procedures through which sensory thresholds are determined is known as psychophysical methods. These methods make assessment of psychological intensity, the magnitude of sensation, easy. It was believed by Gustav Fechner, the founder of psychophysics, that sensations cannot be compared to physical stimuli but they can be easily compared to each other. A person can compare two of his own sensations and judge whether the two are the same or different.

B.8.1 Weber's Law

Ernst Weber first noticed the relationship between the size of the reference stimulus and the size of the j.n.d., but it was his brother-in-law, Gustav Fechner, who formulated it into a general law. Fechner called this relationship Weber's law.

Weber gave the observation that the size of the difference threshold is proportional to the intensity of the standard stimulus. This ratio is constant. The size of the difference threshold, a constant ratio of the standard stimulus, is often referred to as **Weber Fraction**. This example will make this law more clear. Suppose that you can just tell the difference between 100 and 104 grams then you will be able to just distinguish between 200 and 208 grams, 400 and 416 grams and so forth.

Fechner labelled it as Weber's law which is algebraically put as

DI/I = C

Where,

- DI is the increment in stimulus intensity (i.e. the j.n.d.)
- I is the stimulus intensity (the standard stimulus)
- C is constant

Many studies were conducted in the past to see whether Weber's law holds for all of the sensory modalities. It was verified in most of the cases except a few where the nervous system geared to notice relative differences rather than absolute ones. This law allows us to compare the sensitivities of different sensory modalities.

Suppose you want to know, whether eye is more sensitive than the ear. This can be seen using Weber's law. If Weber 's ratio is small, the discriminative power of the sense modality is great and vice-versa. This law helps in understanding the salient features of different sense modalities. It has been found out, using this law, that humans are keen in discriminating brightness than loudness, the Weber's fraction being 1/62 and 1/11 respectively.

B.8.2 FECHNER'S LA W

You have seen that Weber's law postulates that the more intense the stimulus, the more the stimulus intensity needs to be increased before the person gets a change. Gustav Fechner, with a number of assumptions, generalised Weber's findings which indicated a broader relationship between sensory and physical intensity.

Fechner's law stated that the strength of a sensation grows as the logarithm of stimulus intensity. The formula is

S = K log I

Where S is psychological (i.e. subjective) Magnitude

I is stimulus intensity

K is constant

Fechner's law makes good biological sense as our nervous system compress huge range of sensation awareness into some manageable scope, and this is what a logarithmic transformation does for us. If The physical stimulus intensity varied in term of Geometric Progression (say 1, 2, 4, 8, 16, 32 …) our sensation varied in terms of arithmetic progression (0, 2, 4, 6, 8, 10 …). The "log" term shows that

the physiological information processing system compresses large physical intensity ranges into smaller physiological response ranges.

B.8.3 Applications

Designers need to design systems that people can access and use. User feedback, error-proofing, safety warnings related to operating conditions (temperature, speed, etc.) are all examples of providing a signal or stimuli to the user for normal, safe operations of a system. Users must be able to perceive the signal or stimuli in order to taker appropriate actions. The insights provided by Weber's Law, Fechner's Law inform designers as to the creation of accessible and usable systems.

Designers of warning systems and displays need to be aware of Weber's Law, Fechner's Law and their implications for product design.

Designers can use every human sense as a method of communication. Sound, vision, and tactile stimuli have already been discussed. Smell is used as a warning for natural gas in that an additive provides the unique smell we call "gas." Food quality is a multi-sensory phenomenon. Taste is certainly a critical component. Chefs, cooks, and other food designers are critically concerned with taste and design specific dishes to have specific tastes. The sense of smell and taste are central in assessing whether food has spoiled.

In summary - understanding how humans process signals and sensory stimuli are critical to the design of accessible and usable systems.

B.9 Signal Detection

Recent development in psychophysics takes suitably the problem of response bias attitude in sensory experience. Green and Swets (1966) described detection experiment on the basis of which a theory was developed known as 'signal detection theory'. This theory suggests that these are no absolute thresholds for sensations. Rather, detection of stimuli depends on their physical energy and on external factors (organismic factors) such as the relative costs and benefits associated with detecting their presence.

The **signal detection theory**, states that our ability to detect a stimulus depends not just on the intensity of the signal but on many internal factors.

Signal detection theory has a somewhat different testing technique in which catch trials are a regular part of the procedure rather than just an occasional check to keep the subjects on their toes. To know whether the subject can detect the presence of a stimulus, a fairly weak stimulus is selected and presented on half of its trials. On the other half of the trials 'no stimulus' is presented.

Either the stimuli (i.e. the 'weak stimulus') or 'no stimuli' are presented in random order. Two kinds of errors may be committed by the subject. One is a '**miss**', not reporting a stimulus when present; another is a '**false alarm'**, reporting a stimulus when, in fact, not present.

Two kinds of correct responses may also be given- Reporting a stimulus when it is actually present (**'hit'**) and not reporting it when none is present (**'correct negative'**).

The detection experiment gives a basis for getting at the non-sensory factors underlying response bias. One is differential payoff based on 'payoff matrix'.

That is , in this you pay a subject for every 'hit' and 'correct negative' and penalise for every 'miss' and 'false alarm' as per prescribed schedule of gains and losses.

	Responds Yes	**Responds No**
Stimulus present	Hit	Miss
Stimulus absence	False Alarm	Correct rejection (Correct negative)

	Subject says 'yes'	**Subject says 'no'**
Stimulus present	Rs. +10 (Hit)	Rs. -10 (Miss)
Stimulus absence	Re. -1 (False Alarm)	Rs. +5 (Correct negative)

According to the signal detection theory, the probability of detecting a stimulus at any given time depends on the intensity of the stimulus and on the observer's response bias–his or her decision to respond in a certain way. The response bias is influenced by the situation's potential rewards and costs.

When the rewards for Hit are high and the costs for a false alarm are low, the observer will be biased to respond–to detect the stimulus. This will lead to a 'bias' toward 'yes' judgements. With this payoff matrix, the subject will do well to adopt a liberal criterion and give a 'yes' judgement whenever the subject is in doubt. In other words, when consequences of making a miss are so grave, we lower the criteria for considering something as a hit. In this way we increase the number of false alarms, while trying to boost hit detection.

Alternatively, when the rewards for correct rejection are high and the costs for a miss are low, the observer will be biased to not detect the stimulus. This will lead to a 'bias' toward 'no' judgements. With this payoff matrix, give a 'no' judgement whenever the subject is in doubt, therefore chances of **miss** is increased.

The original method of establishing absolute thresholds assumed that the threshold was determined entirely by the stimulus. The newer method of signal detection recognizes that the individual brings certain biases to each situation, and these biases affect the threshold. There biases and the general idea of signal detection have important implications. For example, consider the air traffic controller who must detect blips on a radar screen. Here an error in detection could result in a mid–air collision.

B.10 Vigilance

Vigilance refers to a person's ability to attend to a field of stimulation over a prolonged period, during which the person seeks to detect the appearance of a particular target stimulus of interest.

When being vigilant, the individual watchfully waits to detect a signal stimulus that may appear at an unknown time. Typically, vigilance is needed in settings where a given stimulus occurs only rarely but requires immediate attention as soon as it does occur. Military officers watching for a sneak attack/infiltration are engaged in a high-stakes vigilance task.

In one study, participants watched a visual display that looked like the face of a clock (Mackworth). A clock hand moved in continuous steps. The participants' task was to press a button as soon as possible after observing a double step on the clock. Participants' performance began to deteriorate substantially after just half an hour of observation (missing close to 25% of double steps). It appears that decreases in vigilance are not primarily a result of participants' decreased sensitivity. Rather, they are due to theier increased doubtfulness about their perceived observations (Broadbent &Gregory). To relate these findings to SDT, over time it appears that participants become less willing to risk reporting false alarms. They thereby show higher rate of misses. Training can help to increase vigilance (Fisk & Schneider).

In tasks requiring sustained vigilance, fatigue hinders performance. So there may be no substitute for frequent rest periods to enhance signal detection.

Attentional processes governing signal detection also appear to be highly localised and strongly influenced by expectation (Motter). Neurological studies show that signal detection of a visual stimulus is greatest at the point where a signal is expected to appear. Accuracy of signal detection falls off sharply as the appearance of the stimulus occurs farther from the locus of attention (LaBerge & Brown). Thus, a busy lifeguard or air traffic controller may respond quickly to a signal within a narrow radius of where a signal is expected to appear. But signal appearing outside the concentrated range of vigilant attention may not be detected as quickly or as accurately.

Increase vigilance is seen in cases where emotional stimuli are used. The amygdala plays a pivotal role in the recognition of emotional stimuli. Thus, the amygdala appears to be an important brain structure in the regulation of vigilance (Phelps).

Vigilance is extremely important in warding off terrorist attacks of various kinds. For instance, repeating announcements at airports, metro stations and public places ask public to be vigilant in looking for unattended baggage, which may contain explosives. Because luggage is such a common site in these places, it is difficult to spot bags that are lying unattended. The costs of failure of vigilance, in today's world, can be great loss of life as well as property.

C. Attention

A large number of stimuli impinge upon our sense organs simultaneously, but we do not notice all of them at the same time. Only a selected few of them are noticed. For example, when you enter your classroom you encounter several things in it, such as doors, walls, windows, paintings on walls, tables, chairs, students, schoolbags, water bottles, and so on, but you selectively focus only on one or two of them at one time. Attention is 'the concentration of mental effort on sensory or mental events'. It is the process through which certain stimuli are selected from a group of others.

It may be noted that besides selection, attention also refers to individual's several other properties like alertness, concentration and search. Alertness refers to an individual's readiness to deal with stimuli that appear before her/him. While participating in a race in your school, you might have seen the participants on the starting line in an alert state waiting for the whistle to blow in order to run. Concentration refers to focusing of awareness on certain specific objects while excluding others for the moment. For example, in the classroom, a student concentrates on the teacher's lecture and ignores all sorts of noises coming from different corners of the school. In search an observer looks for some specified subset of objects among a set of objects. For example, when you go to fetch your younger sister and brother from the school, you just look for them among innumerable boys and girls. All these activities require some kind of effort on the part of people. Attention in this sense refers to "effort allocation".

Attention has been classified in a number of ways. A crucial distinction is made between:

1. The mechanisms by which certain information is registered and other information is rejected, whether or not the latter enters conscious awareness (selective or focused attention)
2. Some upper limit to the amount of processing that can be performed on incoming information at any one time (capacity or divided attention).

C.1 Selective Attention

Selective attention is concerned mainly with the selection of a limited number of stimuli or objects from a large number of stimuli. our perceptual system has a limited capacity to receive and process information. This means that it can deal only with a few stimuli at a given moment of time. The question is which of those stimuli will get selected and processed? Psychologists have identified a number of factors that determine the selection of stimuli.

Factors Affecting Selective Attention

Several factors influence selective attention. These generally relate to the characteristics of stimuli and the characteristics of individuals. They are generally classified as "external" and "internal" factors.

External factors are related to the features of stimuli. Other things held constant, the size, intensity, and motion of stimuli appear to be important determinants of attention. Large, bright, and moving stimuli easily catch our attention. Stimuli, which are novel and moderately complex, also easily get into our focus. Studies indicate that human photographs are more likely to be attended to than the photographs of inanimate objects.

Similarly, rhythmic auditory stimuli are more readily attended to than verbal narrations. Sudden and intense stimuli have a wonderful capacity to draw attention.

Internal factors lie within the individual. These may be divided into two main categories, viz. motivational factors and cognitive factors. Motivational factors relate to our biological or social needs. When we are hungry, we notice even a faint smell of food. A student taking an examination is likely to focus on a teacher's instructions more than other students.

Cognitive factors include factors like interest, attitude, and preparatory set. Objects or events, which appear interesting, are readily attended by individuals. Similarly we pay quick attention to certain objects or events to which we are favourably disposed.

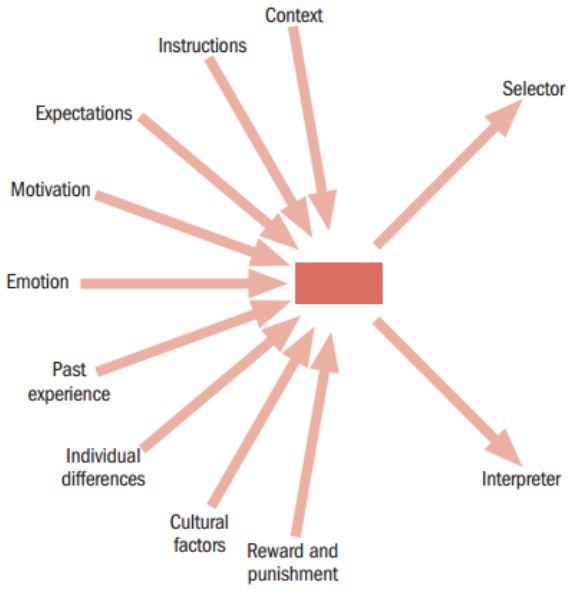
C.1.1 Preparatory set

Set generates a mental state to act in a certain way and readiness of the individual to respond to one kind of stimuli and not to others. It is a bias or predisposition or readiness to attend particular features of a stimulus.

According to Vernon (1955), set acts as:

- a selector– the perceiver has certain expectations that help focus attention on particular aspects of the incoming sensory information, and
- An interpreter– the perceiver knows how to deal with the selected data, how to classify, understand and name them, and what inferences to draw from them.

Several factors can influence or induce set, most of them being perceiver (or organismic) variables. But some relate to the nature of the stimulus or the conditions under which it's perceived (stimulus or situational variables). Both types influence perception indirectly, through directly influencing set which, as such, is a perceiver variable or characteristic.



C.1.2 Selective attention on auditory task

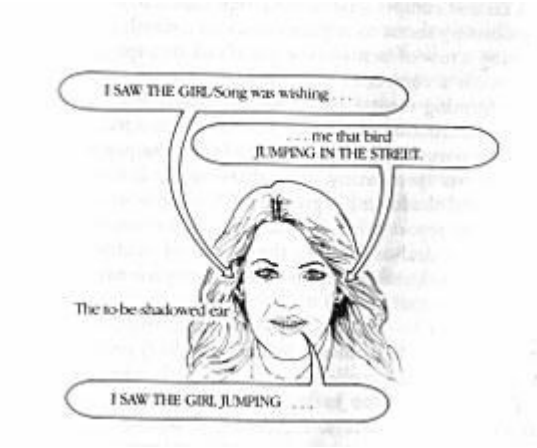
In his initial experiments, Cherry's participants wore headphones through which pairs of spoken prose 'messages' were presented to both ears simultaneously (binaural listening). Cherry found that various physical differences affected a person's ability to select one of the messages to attend to, in particular, voice intensity, the speaker's location and the speaker's gender. He also found that when these differences were controlled for in the two messages (so that each message was, say, spoken in an equally intense female voice), their meaning was extremely difficult to separate. In later experiments, he used dichotic listening and shadowing (in which one message is fed into the left ear and a different message into the right ear. Participants have to repeat one of these messages aloud as they hear it). While participants were able to shadow the specified message, they remembered little of the non-shadowed message.

These data suggested that while the physical properties of the message in the non-shadowed ear were 'heard', semantic content (its meaning) was completely lost.

Other research findings using shadowing

- Little of the non-shadowed message was remembered, even when the same word was presented 35 times to the non-shadowed ear (Moray, 1959).
- Participants didn't notice if the message was spoken in a foreign language or changed from English to a different language.
- Participants noticed when the voice of the unattended message was switched from male to female.
- People also recognized their own name in the unattended message (Moray)

Furthermore, in some cases people can follow meaning in the unattended ear. Treisman presented two messages to participants in her study.



Treisman found that people sometimes followed the meaningful sentence and began to shadow the message in the ear they were supposed to ignore. The participants in the study reported that they were unaware that the meaningful sentence had shifted to the unattended ear.

To what extent do people notice semantic aspects of the unattended message is controversial. The answer probably depends upon the task characteristics. For example, the meaning of the unattended message is presented in the left ear (Dawson & Schell). Still, meaning is less noticeable than characteristics such as pitch (Allport).

Broadbent's split-span studies - Broadbent (1954) reported the results of a series of studies using the split-span procedure. In this, three digits (such as 8, 2 and 1) are presented via headphones to one ear at the rate of one every half a second. Simultaneously, three different digits (such as 7, 3 and 4) are presented to the other ear. The task is to listen to the two sets of numbers and then write down as much as can be remembered.

The digits can be recalled either:

1. According to the ear of presentation (ear-by-ear recall) the numbers above could be recalled as either 8, 2, 1, 7, 3, 4 or 7, 3, 4, 8, 2, 1, or

2. According to their chronological order of presentation (pair-by-pair recall); since the digits have been presented in pairs, this would involve recalling the first pair (8, 7 or 7, 8), followed by the second pair (2, 3 or 3, 2) and finally the third pair (1, 4 or 4, 1).

When people are simply given a list of six digits at a rate of one every half a second, serial recall is typically 95 per cent accurate. However, Broadbent found that the split-span procedure produced accurate recall only 65 per cent of the time. Moreover, pair-by-pair recall was considerably poorer than ear-by-ear recall. If given a choice, people preferred ear-by-ear recall.

C.1.3 Selective attention in visual task

The Stroop Effect refers to the observation that people take much longer to name the colour of a stimulus when it is used in printing an incongruent word than when it appears as a solid colour square. They have trouble saying "Blue" when blue ink is used in printing the word RED.

The Stroop effect demonstrates the effects of selective attention because people take longer to name a colour when they are distracted by another feature of the stimulus, namely, the meaning of the words themselves.

J.R. Stroop found that people required an average of 110seconds to name the ink colour of 100 words that were incongruent colour names. In contrast, people required an average of only 63 seconds to name the ink colour of 100 solid coloured squares.

In recent review by MacLeod, believes that most promising account in explaining Stroop effect is provided by a parallel distributed processing approach. According to this explanation, the Stroop effect activates two pathways at the same time. One pathway is activated by the task of naming the ink colour, and the other pathway is activated by the task of reading the word. Interference occurs when two competing pathways are active simultaneously.

C.2 Divided Attention

Divided attention involves concentrating on more than one activity at the same time.

In day-to-day life we attend to several things at the same time. You must have seen people driving a car and talking to a friend, or attending to phone calls on a mobile set, or putting on sunglasses, or listening to music. If we watch them closely, we will notice that they are still allocating more effort to driving than to other activities, even though some attention is given to other activities

Allport et al.(1972) showed that skilled pianists were able to read music successfully while shadowing speech. Later, Shaffer (1975) reported the case of an expert typist who could type accurately from sight while shadowing speech. But perhaps the most striking example of dual task performance comes from Spelke et al.(1976), who had two students spend five hours a week training at performing two tasks simultaneously.

Initially, the students were required to read short stories while writing down dictated words. At first they found this difficult, and both their comprehension and writing suffered. But after six weeks of training, they could read as quickly, and comprehend as much of what they read, when reading with dictation as when reading without it. Interestingly, though, they could remember very little of what they'd written down, even though thousands of words had been dictated to them over the course of the experiment.

At this point, the task was altered and the students had to write down the category a word belonged to (requiring more processing of the words), while simultaneously reading the short stories. Although the task was again difficult initially, they eventually performed it without any reduction in their comprehension of the stories.

It indicates that on certain occasion attention can be allocated to more than one thing at the same time. However, this becomes possible only with highly practiced activities, because they become almost automatic and require less attention to perform than new or slightly practiced activities.

Automatic processing has three main characteristics; (i) It occurs without intention, (ii) It takes place unconsciously, and (iii) It involves very little (or no) thought processes (e.g., we can read words or tie our shoelaces without giving any thought to these activities).

Schneider and Shiffrin (1977; Shiffrin and Schneider, 1977) distinguish between controlled and automatic attentional processing as follows:

●**Controlled processing** makes heavy demands on attentional resources, is slow, capacity-limited, and involves consciously directing attention towards a task.

●**Automatic processing** makes no demands on attentional resources, is fast, unaffected by capacity limitations, unavoidable and difficult to modify (it always occurs in the presence of an appropriate stimulus), and isn't subject to conscious awareness.

The results of several studies (e.g. Schneider and Fisk, 1982) are consistent with Schneider and Shiffrin's view. If people are given practice at a task, they can perform it quickly and accurately, but their performance is resistant to change. An example of apparent automaticity in real life occurs when we learn to drive a car. At first, focused attention is required for each component of driving, and any distraction can disrupt performance. Once we've learned to drive, and as we become more experienced, our ability to attend simultaneously to other things increases.

Despite its intuitive appeal, it's unclear whether automaticity results from a speeding up of the processes involved in a task, or a change in the nature of the processes themselves. Also, the view that automatic processing makes no demands on attention has been challenged by findings indicating that allegedly automatic tasks do influence the performance of simultaneously performed tasks (e.g. Hampson, 1989). Additional problems occur with the Stroop effect. The Stroop effect shows that well-learned, automatic skills (such as reading) can interfere with other tasks (such as naming the colour of a written word)

C.2.1 Multitasking: can anyone really do several things at once?

The evidence discussed above regarding divided attention suggests that under certain controlled conditions, people can learn to perform two tasks simultaneously that we'd normally consider impossible to do. At the opposite extreme are the people killed and seriously injured in accidents caused by drivers talking on their mobile phones.

According to Marois (in Motluk, 2007), there are three 'sticking points 'in our ability to multitask:

1. Simply identifying what we're looking at can take a few tenths of a second, during which time we're unable to see and recognise a second item (the attentional blink).

Experiments have shown that if you're looking out for a particular event and a second event occurs unexpectedly within this few-tenths-of-a-second 'window', it may register in your visual cortex but you'll be unable to act on it.

2. It's estimated that we can keep track of about four items at a time (fewer if they're complex). This capacity shortage can help explain **change blindness**.

3. Choosing which stimulus to respond to also takes some tenths of a second (response selection bottleneck).

Consistent with Marois's interpretation is Poppel's claim that it's impossible to perform two or three different tasks simultaneously with the same degree of concentration. Apparently simultaneous

awareness and processing of information actually takes place in 'three-second windows': in these three-second increments, the brain takes in all the data about the environment as a block and subsequent events are then processed in the next window.

C.3 Biological Basis of Attention

Many researchers are interested in the brain regions involved in attention (e.g. Driver; Halligan; Muller and Maxwell). People who've suffered a right-hemisphere stroke involving the parietal lobe may completely ignore stimuli occurring on the left side. For example, they may fail to eat food from the left side of their plate, and be unaware of their body on that side. The fascinating thing about this *unilateral visual neglect* is that these effects occur even though the pathways from the receptors to the central nervous system for the neglected information remain intact.

The ARAS is vitally important in maintaining our general level of arousal or alertness (it's often called the 'consciousness switch') and plays an important part (but by no means the only one) in the sleep–wake cycle. It also plays a part in selective attention. Although it responds unselectively to all kinds of stimulation, it helps to screen extraneous sensory information by, for example, controlling habituation to constant sources of stimulation, and making us alert and responsive mainly to changes in stimulation.

Much of the research uses the **regional cerebral blood-flow technique** that measures the blood flow within the cerebral cortex; changes in blood flow indicate neural activity. Parietal cortex shows increased blood flow when people pay attention to spatial locations.

Another important method in the research on the biological basis of attention involves clinical studies on people with **lesions**, or specific brain damage caused by strokes, accidents, or other traumas. People who have who have brain damage in the parietal region of the right hemisphere of the brain have trouble noticing a new visual stimulus that appears on the left side of their visual field. According to Posner and Petersen, the parietal lobe is responsible for disengaging attention from its present focus, and patients with damage to the pulvina nucleus (part of the thalami) have difficulty in shifting attention to a new target (Rafal and Posner).

Evoked potential technique, which records electrical signals generated from a large number of neurons located underneath an electrode. This technique has been used to demonstrate direct neuron activity during attention. For example, a research group in Finland instructed people to listen to a series of tones. Most were tones of a particular pitch, but sometimes a higher pitched tone was included (eg. Sam et al). In some conditions, the participants were instructed to press a response key whenever they heard this deviant tone. In these conditions, the electrical activity pattern showed a new component. However, this component was absent when participants were tested in other conditions, where they had been instructed to ignore the higher pitched tone. This research, therefore, identifies a clear-cut neurological correlate of attention.

D. Perception

D.1 The Process of Perception

If the primary function of sensation is to take in information, the primary function of perception is to help us make sense of that information. Perception allows us to impose a logic and order on the chaos of the millions of stimuli that bombard our senses. Even though our eyes detect lights and colors and our ears react to tones of different loudness, pitch, and timbre, we do not see or hear the world as a random array of light, dark, and colors, nor do we hear random tones of different loudness and pitch. Instead, perception allows us to make sense out of these sensations.

Although psychologists do make a distinction between sensation and perception, it is not always clear where sensation ends and perception begins. In fact, some researchers have argued that it is impossible to make such a distinction. Our eyes, for example, do not register or transduce all waves in the electromagnetic spectrum. Our eyes are sensitive only to the so-called visible light waves; we are unable to see, for instance, radio waves or X-rays. By being selective, our eyes in a sense interpret what we see. Thus, vision, generally considered a sensory process, might also be considered a perceptual process.

To understand what psychologists mean by the process of perception and how it differs from sensation, try this demonstration. If you are like most people, you probably saw a man, a seal, a whip, a ball, and a fish. Now look at the poster again, but this time think of if as a poster for a costume ball. Now what do you see? Suddenly, the seal becomes a women, the whip a sword, the fish a hat, and the ball a woman's head. In both instances, the stimulus and sensation remained the same-only your perception changed.

The process by which we recognise, interpret or give meaning to the information provided by sense organs is called perception. In interpreting stimuli or events, individuals often construct them in their own ways. Thus perception is not merely an interpretation of objects or events of the external or internal world as they exist, instead it is also a construction of those objects and events from one's own point of view.

Psychologists divide the process of perception into three processes: **selection, organization,** and **interpretation**. Most research in perception has focused on organization and interpretation and so will we. Before we discuss these processes, however, we would like to briefly mention the selection process.

1. Selection

The first step in perception is the selection of specific sensations. As we monitor the thousands of sensations in our environment, we focus on some and disregard others. **Attention** is the process by which we determine which sensations will be perceived. Attention is just one aspect of our state of awareness or consciousness.

2. Organization and Perception

Organizing sensations is a fundamental perceptual process. In this section, we will discuss the three basic types of perceptual organization. The first, form perception, refers to how stimuli are organized into meaningful shapes and patterns. For example, how do you organize the pattern of lines on this page into meaningful letter and words? A second type of perceptual organization deals with depth and distance perception. How are we able to organize the world into three dimensions when our retina records only two-dimensional images? A related issue is how we perceive depth in a two-dimensional picture. A third aspect of perceptual organization deals with perceptual constancies. For example, why do we perceive the shape of an object to be constant, even though the shape of the image that strikes our retina is affected by the angle from which the object is viewed? The image of a plate is perfectly round only when we stare down directly at it. Viewed slightly from the side, the plate produces an oval image. But we still perceive the plate as round.

D.1.1 Processing Approaches in Perception

How do we identify an object? Do we identify a dog because we have first recognised its furry coat, its four legs, its eyes, ears, and so on, or do we recognise these different parts because we have first identified a dog?

The idea that recognition process begins from the parts, which serve as the basis for the recognition of the whole is known as **bottom-up processing** (or data driven). The bottom-up approach lays emphasis

on the features of stimuli in perception, and considers perception as a process of mental construction. They argue that our perception of the world is essentially determined by the information presented to the sensory receptors, so that things are perceived quite directly.

The notion that recognition process begins from the whole, which leads to identification of its various components is known as **top-down processing** (or conceptually driven). The top-down approach lays emphasis on the perceiver, and considers perception as a process of recognition or identification of stimuli. Making inferences about what things are like means that we perceive them *indirectly*, drawing on our knowledge and expectations of the world.

Studies show that in perception both the processes interact with each other to provide us with an understanding of the world.

D.2 Perceptual organization

Organizing sensations is a fundamental perceptual process. In this section, we will discuss the three basic types of perceptual organization. The first, form perception, refers to how stimuli are organized into meaningful shapes and patterns. For example, how do you organize the pattern of lines on this page into meaningful letter and words? A second type of perceptual organization deals with depth and distance perception. How are we able to organize the world into three dimensions when our retina records only two-dimensional images? A related issue is how we perceive depth in a two-dimensional picture. A third aspect of perceptual organization deals with perceptual constancies. For example, why do we perceive the shape of an object to be constant, even though the shape of the image that strikes our retina is affected by the angle from which the object is viewed? The image of a plate is perfectly round only when we stare down directly at it. Viewed slightly from the side, the plate produces an oval image. But we still perceive the plate as round.

D.2.1 Form Perception

In order to structure incoming sensory information, we must perceive objects as being separate from other stimuli and as having meaningful form.

Form perception-how sensory stimuli are organized into meaningful shapes and patterns- was one of the first topics studied by psychologists. Wilhelm Wundt is generally given credit for establishing the first psychology laboratory at the University of Leipzig in 1875. In the course of his experiments on conscious experience, Wundt also made some important discoveries about form perception.

In one experiment, Wundt asked his subjects to describe the experience of listening to a metronome. The metronome played a simple pattern of regularly repeated ticks. Each tick produced the same sound and the ticks occurred at evenly spaced intervals, one right after the other. Yet when Wundt asked his subjects to describe what they had heard, almost all reported hearing patterns more complex than the simple repetition of individual ticks. Some subjects heard paired beats. Others grouped the ticks into even more complex-and irregular-rhythms. Wundt's simple study was one of the first clues that we tend to organize sensory information into specific forms and patterns.

Perhaps the first group of psychologists to systematically study form perception were the Gestalt Psychologists. Ehrenfels (1890) claimed that many groups of stimuli acquire a pattern quality that is greater than the sum of their parts. A square, for example, is more than a simple assembly of lines – it has 'squareness'. Ehrenfels called this 'emergent property' Gestalt qualität(or form quality). In the early 1900s, Gestalt psychologists (notably Wertheimer, Koffka and Köhler) attempted to discover the principles through which sensory information is interpreted. The Gestalt psychologists felt that to understand human perception, it was necessary to understand how humans organize many stimuli into

a single, meaningful, whole image. They argued that as well as creating a coherent perceptual experience that's more than the sum of its parts, the brain does this in regular and predictable ways. They believed that these organisational principles are innate.

D.2.1.1 Figure-Ground Relationships

One of the basic laws proposed by the Gestalt psychologists is the principle of **figure-ground** relationships, which states that we organize stimuli into figures and grounds. For example, when we look at this page the words (the black ink) stands out as a figure against the ground, or background, of the white page. Similarly, we see a picture on a wall as a figure and the wall as a background. In general, the figure in a figure-ground relationship takes on a meaningful form, and the background is perceived as formless and neutral.

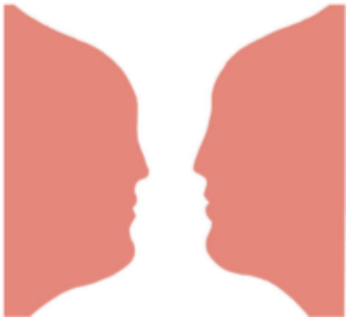
We distinguish figure from the ground on the basis of the following characteristics:

1. Figure has a definite form, while the background is relatively formless.
2. Figure is more organised as compared to its background.
3. Figure has a clear contour (outline), while the background is contourless.
4. Figure stands out from the background, while the background stays behind the figure.
5. Figure appears more clear, limited, and relatively nearer, while the background appears relatively unclear, unlimited, and away from us.

Sometimes, though, there may not be enough information in a pattern to allow us to distinguish easily between figure and ground. A good example of this is shown in Figure 15.2, which illustrates the principle underlying camouflage.

Figure 15.2 The dalmatian dog (the figure) is difficult to distinguish from the ground because it has few visible contours of its own

In **figure–ground reversal,** a figure may have clear contours, but is capable of being perceived in two very different ways: it's unclear which part of it is the figure and which the ground. A famous example is Figure below, usually called Rubin's vase (Rubin, 1915). Here, the figure–ground relationship continually reverses, so that it's perceived as either a white vase with a dark background, or two dark profiles on a white background. However, the stimulus is always organised into a figure seen against a ground, and the reversal indicates that the same stimulus can trigger more than one perception



A map is another example. We normally see the land as figure and the sea as (back)ground, because we're more familiar with the shape of Africa, say, than with the shape of the Atlantic ocean. An auditory example is the cocktail party phenomenon. Here's another: try repeating 'over-run' out loud and you'll find the two words alternating as figure and ground.

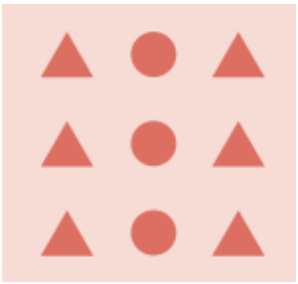
D.2.1.2 Grouping

Once we've discriminated figure from ground, the figure can be organised into a meaningful form. Gestalt psychologists believed that objects are perceived as gestalten ('organised wholes', 'configurations' or 'patterns') rather than combinations of isolated sensations. Based on the results of many experiments performed in the 1920s and 1930s, the Gestalt psychologists proposed basic laws of form perception, which illustrate their view that the perceived whole of an object is more than the sum of its parts.

D.2.1.3 Gestalt laws of perceptual organisation

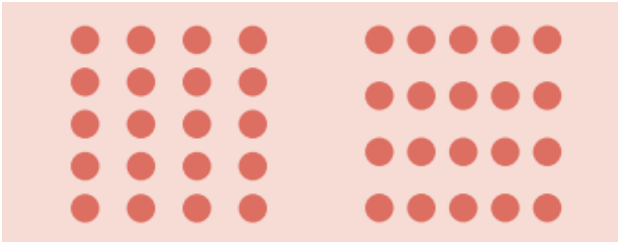
1. Similarity

Another law proposed by the Gestalt psychologists is that of similarity-that similar elements within a perceptual field tend to be grouped together. For example, most people see as horizontal rows of dots and squares, not as vertical columns that contains dots and square alternately. Similar figures tend to be grouped together. So, the triangles and circles below are seen as columns of similar shapes rather than rows of dissimilar shapes.



2. Proximity

The law of **proximity** (nearness) states that objects near each other tend to be grouped together. Most people see the left pattern as a set of columns, not a set of rows. This occurs because the dots are closer to one another on the vertical dimensions. In the right patterns, however, the dots are closer horizontally and are perceived as a set of rows .



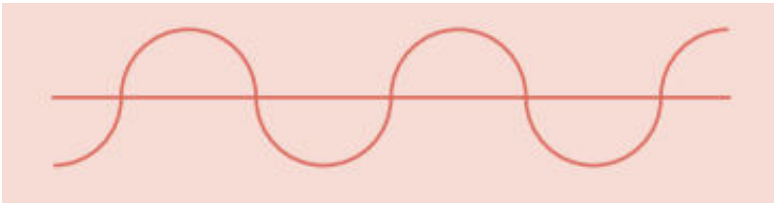
3. Closure

The Gestalt law of **closure** states that we tend to fill in the gaps incomplete stimuli. If part of a familiar pattern or shape is missing, our perceptual processes complete the pattern and allow us to perceive the whole form. You may have experienced this yourself if you have ever observed how artists can suggest a well-known face just by sketching a few lines.

An interesting phenomena that is closely related to closure is **subjective contour**. These are contours that are perceived even though they do not physically exist. Some researcher interpret subjective contours as special instances of closure.

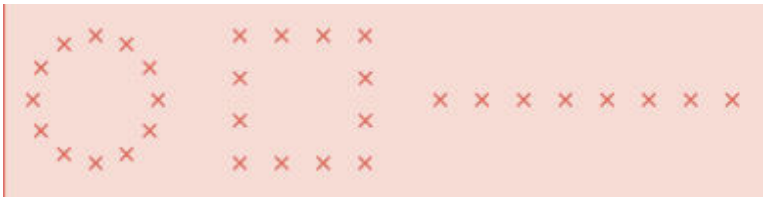
4. Good Continuation

The Gestalt law of **good continuation** states that we tend to organize stimuli into continuous lines or patterns. For example, the pattern below could be seen as a series of alternating semicircles, but tends to be perceived as a wavy line and a straight line. We expect the curved line to be curved throughout the figure, and the straight lines to be straight.



5. Part–whole relationship

As well as illustrating continuity and proximity, the three figures below illustrate the principle that 'the whole is greater than the sum of its parts'. Despite the similarity of the parts (each pattern is composed of 12 crosses), the *gestalten* are different.



The same melody can be recognised when hummed, whistled or played with different instruments and in different keys.

6. Common fate

Elements seen moving together are perceived as belonging together. This is why a group of people running in the same direction appear to be unified in their purpose.

7. Simplicity

The law of **simplicity** predicts that we will organize a stimulus pattern into its simplest components. The law of perceptual organization are apparent in many situations. For example, the law of proximity and similarity are often used by advertisers. Consider an ad for an air conditioner that shows a rounded cat curled up next to the rounded corners of the rounded grid on the air conditioner. According to Zaika, the viewer would tend to group the car and the air conditioner because of the law of similarity (the rounded corners). This grouping would then encourage the association between the quietness of the sleeping cat and the implied quietness of the air conditioner.

D.2.1.4 An evaluation of the Gestalt contribution

A major philosophical influence on Gestalt psychology was *phenomenology*, which refers to our individual experience of the world. Koffka, for example, believed that the most important question for perceptual psychologists was 'Why do things look as they do?', and for Köhler (1925): "There seems to be a single starting point for psychology, exactly as for all the other sciences: the world as we find it, naïvely and uncritically."

The most comprehensive account of perceptual grouping (or organization) is still that provided by the Gestaltist psychologists (Roth, 1986); and in Gordon's (1989) view, Gestalt psychology's discoveries 'are now part of our permanent knowledge of perception'.

However, many contemporary researchers (e.g. Greene, 1990) have argued that, as originally expressed, the various Gestalt 'laws' are at best only descriptive and at worst extremely imprecise and difficult to measure.

Several experimental tests of the Gestalt laws have been conducted. While there's plenty of experimental support, the Gestalt laws are difficult to apply to the perception of solid (three-dimensional/3-D) objects (as opposed to two-dimensional/2-D drawings). Our eyes evolved to see 3-D objects, and when 3-D arrays have been studied, Gestalt laws haven't been consistently upheld (Eysenck). The world around us comprises 'whole' scenes, in which single objects are but 'parts' (Humphreys and Riddoch). Because many of the Gestalt displays involve single objects, they have very low ecological validity, that is, they're not representative of 'the objects and events that organisms must deal with in order to survive' (Gordon).

D.2.1.5 Form Perception and the Brain

The Gestalt psychologists assumed that the brain was designed to organize stimuli in a particular way. But it was not until quite recently that researchers began to provide the first clues as to how the brain codes our perception of form. To be sure, this research has not yet explained all the complexities of form perception, but it has provided an important start.

In these studies, which earned the researchers the 1981 Nobel Prize, **David Hubel** and **Torsten Wiesel** set out to determine if the millions of neurons in the visual cortex respondent differently to different forms. Would one type of neuron respond only to horizontal lines and another only to vertical lines? Moreover, could the response of these individual cells combine to produce the overall perception of a figure?

In order to answer these questions, Hubel and Wiesel implanted a microelectrode in the visual cortex of a cat. They then showed the animal a series of lines and shapes and recorded the activity of individual neurons.

Hubel and Wiesel found that there were three types of specialized neurons in the visual cortex: **simple cells**, **complex cells**, and **hypercomplex cells**. Simple cells responded to lines that were located in a particular place and oriented in a particular place and oriented in a particular way. For example, some of the simple cells would respond only to vertical line in the middle of the screen. Other simple cells would respond only to a horizontal line on another part of the screen. Still others would respond only to a line at a 45-degree angle, and so on.

According to Hubel and Wiesel, a complex cell receives input from many simple cells and responds to lines of a particular orientation located anywhere in the visual field. A hypercomplex cell receives input from many complex cells and responds to particular shapes. In this way, information about different lines in the environment can be combined to form a single image. For example, one simple cell may be excited by this line "/"; a second by this line "\"; and a third by this line "-". If the information from these three simple cortical cells eventually converged on a complex and then a hypercomplex cell, at the lines could combine to form the letter "A" (Hubel & Wiesel).

As Hubel and Wiesel point out, we cannot explain how we see forms in the environment solely on the basis of these specialized cells, but it is possible that we perceive a particular form because that we perceive a particular form because a certain group of hypercomplex cells are stimulated through a building block system.

Are there specialized cells for more complex stimuli? Studies with monkeys indicate that there are cells in the visual cortex that fire when the animals are shown slides of the faces of other monkeys (Bayliss, Rolls, & Leonard). It also appears that similar cells are found in sheep. In a very recent study the researchers found cells in the sheep's visual cortex that fired when a sheep was shown a picture of the sheep that lived in the next pen (Kendrick & Baldwin)! Studies such as these raise the intriguing possibility that there are similar cells in the visual cortex that respond to forms that we encounter regularly.

Although these result are fascinating, the exact nature of the building blocks that make up the visual system is currently under debate. Some researchers argue that the building blocks may not be cells that respond to bars but rather to more complex patterns of light and dark (De Valois, Albrect, & Thorell). Nevertheless, the contribution of Hubel and Wiesel remains very important because it provides a way in which patterns of firing of neurons could lead to the perception of objects. In this sense it shows how a bridge can be made from brain to mind.

D.2.2 DEPTH & DISTANCE PERCEPTION

From the 2-D images that fall on our retinas, we manage to organise 3-D perceptions. This ability is called depth perception, and it allows us to estimate an object's distance from us. Some of the cues used to transform 2-D retinal images into 3-D perceptions involve both eyes and rely on their working together. These are called *binocular cues*. *Monocular cues* are available to each eye separately.

D.2.2.1 Binocular Cues (Non-pictorial cues or Primary cues or Physiological Cues)

Most preyed-upon non-humans (such as rabbits) have their eyes on the sides of the head, allowing them to see danger approaching over a wide area. Most predators (such as lions) have their eyes set close together on the front of the head, equipping them with binocular vision, which helps in hunting

prey. Like non-human predators, humans have predatory vision, which influences the way we perceive the world.

Binocular cues for depth perception result from 4 general processes: *retinal disparity, stereopsis, accommodation and convergence*.

Convergence refers to the process whereby the eye point more and more inward (convergence) as an object gets closer. As the eyes converge (or diverge), they send a message to the brain. The brain interprets this message to mean that the more the eyes are pointed inward, the closer the object. To experience this, hold your finger out at arm's length and then slowly move it toward your nose. As you move your finger closer you may notice that in order to follow it, your eyes must point inward.

A second binocular cue is retinal disparity. ***Retinal disparity*** refers to the fact that, because the eyes are in slightly different locations, a slightly different or disparate view of an object falls on each retina. You can demonstrate retinal disparity by holding your finger about 6 inches from your nose and closing your right eye. Now look at your finger with your left eye alone. Repeat this procedure with your right eye alone. Each eye saw the image of your finger in a slightly different position. It is possible to virtually elimate retinal disparity by performing the same demonstration with your finger held at arm's length. In this case the image of your finger is about the same for both eyes. Thus retinal disparity is greatest for close objects and decreases as objects get farther away. By registering the degree of retinal disparity, the brain gains another cue about the depth of an object.

Ordinarily, we don't see double images, because the brain combines the two images in a process called ***Stereopsis*** (literally, 'solid vision': Harris, 1998). This allows us to experience one 3-D sensation, rather than two different images.

In ***accommodation***, Accommodation refers to a process by which we focus the image on the retina with the help of ciliary muscle. These muscles change the thickness of the lens of the eye. If the object gets away (more than 2 meters), the muscle is relaxed. As the object moves nearer, the muscles contracts and the thickness of the lens increases. The signal about the degree of contraction of the muscle is sent to the brain, which provides the cue for distance.

D.2.2.2 Monocular Cues (Pictorial cues or Secondary cues or Psychological Cues)

Although people with vision in only one eye do not have binocular cues for depth perception, they are still able to perceive depth. This is because some of the cues we use for depth perception are **monocular cues**, cues that can be registered by each eye working independently.

Except with relatively near objects, each eye receives a very similar retinal image when looking ahead. At greater distances, we depend on pictorial cues. These refer to features of the visual field itself (rather than to the eyes), and are all also monocular.

Relative size	In an array of different-sized objects, smaller ones are usually seen as more distant (especially if they're known to have a constant size).
Relative brightness	Brighter objects normally appear to be nearer.
Superimposition (or overlap)	An object which blocks the view of another is seen as being nearer.
Linear perspective	Parallel lines (e.g. railway tracks) appear to converge as they recede into the distance.

Aerial perspective	Objects at a great distance appear to have a different colour (e.g. the hazy, bluish, tint of distant mountains).
Height in the horizontal plane	When looking across a flat expanse (e.g. the sea), objects that are more distant seem higher (closer to the horizon) than nearer objects, which seem lower (closer to the ground).
Light and shadow	3-D objects produce variations in light and shade (for example, we normally assume that light comes from above).
Texture gradient	Textured surfaces (e.g. sand) look rougher close up than from a distance. A stretch of beach looks more smooth and uniform.
Motion parallax	This is the major dynamic depth cue (pictorial/non-pictorial). Objects nearer to us seem to move faster than more distant objects (e.g. telegraph poles seen from a (moving) train window flash by when close to the track)

D.2.3 Perceptual Constancies

Perceptual constancy refers to our ability to perceive objects as relatively stable in terms of size, shape, and color despite changes in the sensory information that reaches our eyes. Once we form a perception of an object, we can easily recognize the object from almost any distance, at almost any angle, and in almost any illumination. We recognize this textbook's color, its rectangular shape, and its size regardless of how far away from the book we are, from what angle we observe the book, or how much light is in the room. The type of constancy that allow us to do this are size and shape constancy and color constancy.

D.2.3.1 Size and Shape Constancy

Emmert's law states that the closer an object is to us, the larger the image it casts on our retina. Thus, an object that is 6 inches away will cast a retinal image that is twice as large as the image cast by the same object 12 inches away. Based on this, we might expect to perceive that an object 6 inches away is twice as large as the same object 12 inches away. But we know from our experience that this does not happen. If we observe two men, one across the street and the other directly in front of us, the man across the street casts a much smaller retinal image. But we do not perceive him as a midget. Instead, he appears to be a normal-sized individual who is at a distance. Similarly, as an automobile approaches us, the size of the retinal image increases. Yet, we do not perceive the car as growing in size; instead, we know that the car maintains a constant size but is getting closer. **Size constancy** is the tendency for the size of familiar objects to be perceived as constant even though the retinal image changes.

Closely related to size constancy is **shape constancy**, the perceptual process-which allows objects to maintain a constant shape even though their orientation or position might change. To demonstrate this, hold our notebook at arm's length and turn it around. Each time you move the book it will cast a slightly different image on the retina. Yet despite the different sensation, you will always perceive a rectangular notebook.

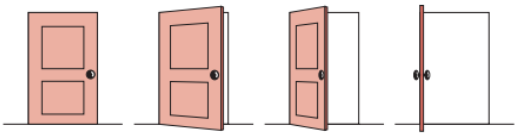


Figure 15.5 No matter what angle a door is viewed from, it remains a door

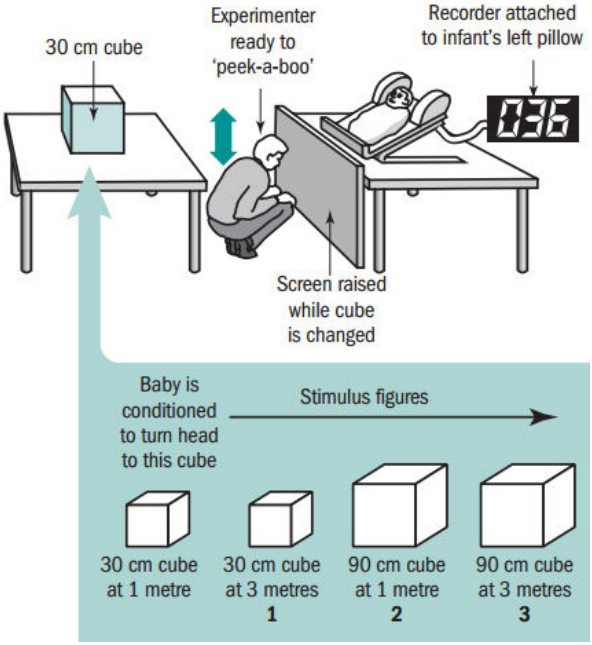
How do we resolve the discrepancy between the retinal image an object casts and its actual shape and size? Familiarity with the object plays an important role. If we are very familiar with the size of an object, such as a friend's height, we will perceive the size as constant no matter how far away it is. Similarly, if we are familiar with the shape of an object, we will perceive its shape as constant no matter what our vantage point. Size constancy is further aided by distance cues. Even when we are not familiar with an object, if there are cues to indicate distance, we will still see it as a constant size. However, in situations in which the object is not familiar and there are not distance cues, the retinal image will prevail. Thus, size and shape constancies seem to be due to experience with various objects. Support for this view comes from studies that show that adults have better size constancy than children.

'Peek-a-boo' and size constancy too (Bower, 1966) To assess nativist and empiricist claims, Bower initially conditioned two-month-olds to turn their heads whenever they saw a 30-centimetre cube at a distance of one meter (an adult popping up in front of the baby whenever it performed the desired behaviour served as a powerful reinforcer). Once the response was conditioned, the cube was replaced by one of three different cubes:

(a) A 30-centimetre cube at a distance of three meters (producing a retinal image one-third of the size of the original)

(b) A 90-centimetre cube at a distance of one meter (producing a retinal image three times the size of the original)

(c) A 90-centimetre cube at a distance of three meters (producing exactly the same-sized retinal image as the original).


30 cm cube
Experimenter ready to 'peek-a-boo'
Recorder attached to infant's left pillow
Screen raised while cube is changed
Baby is conditioned to turn head to this cube
Stimulus figures
30 cm cube at 1 metre
30 cm cube at 3 metres
1
90 cm cube at 1 metre
2
90 cm cube at 3 metres
3

Bower recorded the number of times each stimulus produced the conditioned response (CR), and used this as a measure of how similar the neonate considered the stimulus to be to the original. The original stimulus produced a total of 98 CRs, while (a) produced 58, (b) 54 and (c) 22. This indicates that the baby was responding to the actual size of the cube, irrespective of its distance. This suggests the presence of size constancy, and supports the nativist view that this constancy is inbuilt. Empiricists would have expected (c) to produce the most CRs.

Bower's findings have been replicated with two-day-old babies by Slater et al. (1990). Although these findings demonstrate that size constancy is an organising feature of perception present at birth, learning still plays some part (Slater, 1994). For example, in the Slater et al. study, the procedure depends on infants learning the characteristics of the cubes in the early 'familiarisation trials'.

D.2.3.2 Color Constancy

A third form of constancy that adds order to our perceptual world is color constancy. **Color constancy** refers to the ability to perceive the color of familiar objects as constant even though the sensation of color may change. This means that an orange will appear orange even when you have a green light bulb in your lamp. Color constancy is particularly good for familiar objects (Delk & Fillenbaum), presumably because what we know about the object influences our perception. When we do not already know the color of an object, however, color constancy is not as effective. For example, studies have shown that fluorescent lighting alters our perception of color (Helson, Judd, & Wilson). Anyone who has purchased new clothes that appeared to be one color in the fluorescently it store, only to become a different color at home, will certainly agree. Thus although there is some degree of color constancy for unfamiliar objects, there is a higher degree for objects of familiar color.

In summary, form perception allows us to see objects as coherent wholes, depth and distance perception allows us to locate an object in space, and constancies allow us to recognize object without being deceived by changes in size, shape, or color. These processes allow us to organize stimuli so that we can accurately perceive the world around us.

D.2.4 Illusions

Although perception is usually a reliable process, there are some instances when our perceptions actually misrepresent the world. When this occurs, we experience the sometimes annoying but often fascinating phenomenon of illusion. An **illusion** occurs when our perception of an object does not agree with the true physical characteristics of the object.

Illusions fall into two basic categories: those due to physical distortion of stimuli and those due to our misperception of stimuli. Illusions due to distortions of light are a common example of the first category. A group of researchers demonstrated that when light is refracted (i.e., bent) in a particular way, a stick floating on the water can appear as a "lake monster". This might explain sightings of the Loch Ness monster as well as early sailors' reports of large ocean monsters. Similarly, desert mirages of water occur due to refracted light.

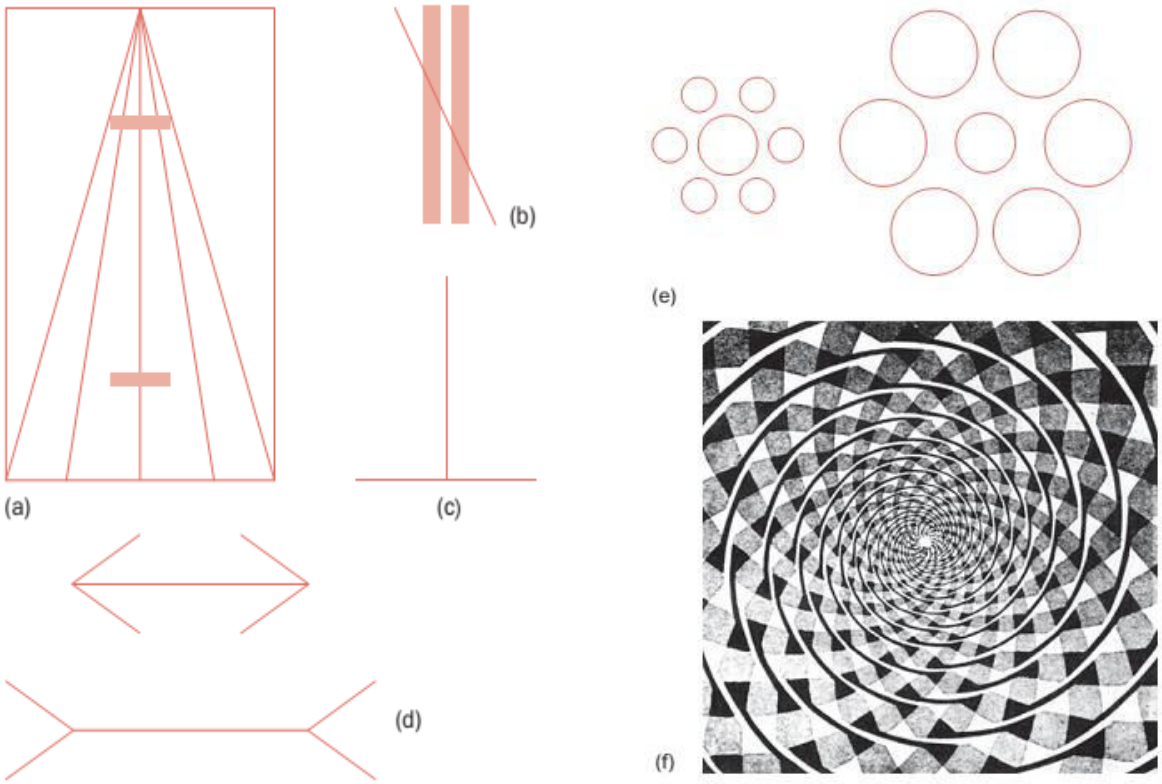
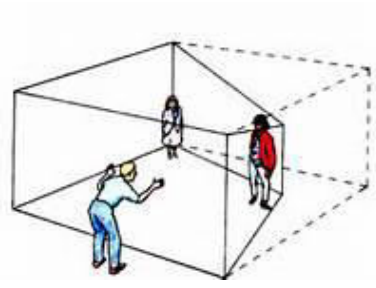


Figure 15.6 Distortions (or geometric illusions). In the Ponzo illusion (a), the horizontal bar at the top is seen as being longer than the horizontal line at the bottom, even though they're both the same length. The Poggendorf illusion (b) suggests that the segments of the diagonal line are offset, even though they're not. The line with the outgoing fins in the Müller–Lyer illusion (c), the vertical line is seen as being longer, although it is the same length as the horizontal line. In Titchener's circles (d) appears to be longer than the line with the ingoing fins, but in fact they're the same length. In the horizontal–vertical illusion (e), the central circle in the left-hand group is seen as being larger than the central circle of the right-hand group, but they're both the same size. Finally, in the twisted card illusion (f), the twisted cards appear to be a spiral pattern, but the circles are, in fact, concentric

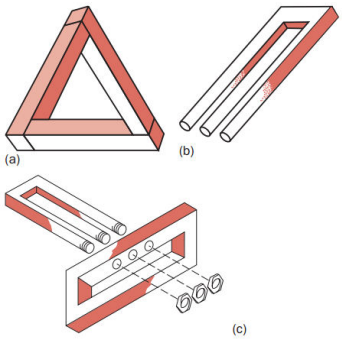
Although illusions produced by distortions of light, and other stimuli are fascinating psychologists have been more concerned with illusions caused by distortions in perceptual processes. By studying these misperceptions, psychologists have learned a good deal about normal perceptual processes.

One illusion which has greatly contributed to the understanding of size constancy is the Ames room. Most people select the person of the right. In actuality, both people are the same size. This illusion is created by the unusual construction of the room. Even though it appears to be a normal, rectangular room, it is not.



It we combine the knowledge of the unusual shape of the room with the principle of size constancy, we begin to understand why this illusion works. Recall that Emmert's law states the farther away an object is, the smaller the retinal image. Since the person on the left is actually much farther away, he casts a smaller retinal image. Under normal conditions, size constancy would correct for this. Since we know by experience that most people are about the same size, we would assume that the person on the left is not smaller, but rather farther away. But the Ames room prevents us from doing this. Because the Ames room is constructed to appear rectangular, the distance cues in the Ames room create the impression that both men are the same distance away. Thus, we assume that the man who casts a smaller retinal image, the man on the left, is much smaller. The illusion produced by the Ames room does not result from a breakdown in normal perception. Rather, the illusion occurs because we try to apply the standard perceptual process of size constancy to an extraordinary situation.

Another example of illusion due to misperception is the impossible figure. This illusion reveals interesting information about how we organize the parts of a figure into a meaningful whole.



At first glance it probably looks like an ordinary figure, but upon closer inspection you will notice that the figure cannot exist in reality. Why does it take a few seconds to realize that the figure is impossible? According to one view, it takes this long to fully examine or scan the figure and organize the parts into a meaningful form (Hochberg). The process by which this scanning takes place is related to eye movements. Although you are probably not aware of it, when you look at a figure your eyes move from place to place on the figure at a rate of about three changes per second (Yarbus). Thus, when we look at the impossible figure it takes several seconds (the more complex the figure, the longer) to scan the picture and perceive the form. Only after scanning can we appreciate the impossible nature of the figure. It too is an impossible figure, but because it is complicated it will take you a bit longer to scan it and to realize that it is impossible.

Illusions also play an important role in perception in natural settings. Consider the natural occurrences of the horizontal-vertical illusion. People have a tendency to overestimate the size of vertical objects such as lamp posts and buildings; thus a tree looks shorter when it is cut down than it does when it is standing (Coren & Girgus). One of the most famous architectural examples of this illusion is the Gateway Arch in St. Louis. Only by measuring can you convince yourself that the height and width are equal. They are both 630 feet.

For the past 100 years, psychologists have used illusions, such as the Ames room and the impossible figure, to help understand perceptual processes.

D.3 Interpretation and Perception

The third process in perception is interpretation. The change you saw in the trained seal act/costume ball poster is an example of perceptual set, or seeing what you were "set" to see. Although the poster did not change, your interpretation of it changed based on what you expected to see. Our expectations are just one of the factors that can affect our interpretation of a sensory stimulus. In this section we will examine this and other factors that affect how we interpret sensory stimuli.

D.3.1 Perceptual Set (Perceptual Readiness)

Perceptual set *(perceptual readiness)* is the tendency for our perception of an object to be influenced by what we except to see (or hear, touch, smell, or taste). One of the earliest and most vivid demonstrations of perceptual set is a picture originally published in Puck magazine in 1915. But it was not until 1930 that the psychologist Edwin Boring recognized it as an instance of perceptual set (1930). Whether the picture it seen as an old woman or a young woman can be influenced by what we see before it. A young woman before we see the ambiguous figure, we see the ambiguous figure as a young woman; if preceded by the picture of an old woman, we perceive the ambiguous figure to be an old woman.

Thus, perceiving and recognizing depend not only on objective qualities / features of the object, but also on the condition the organism is in, called perceptual set (perceptual readiness). Perceptual set is the easiness with which a given category is used for perceiving a given material. It depends on two groups of factors: external and internal. External factors are responsible for learning the probability / likelihood of occurrence of a certain object in a given category. If one expects a given object to occur, he or she will recognize it more easily. A typical example of the influence of external factors is the phenomenon of priming: if man has been previously, consciously or subliminally, informed about the kind of stimuli to be exposed, their recognition will be easier. Internal factors are connected with the internal organization of categories one uses when perceiving.

D.3.2 Motivational Factors

A second factor that can influence our perception is motivational state. Are hungry people more likely to perceive an ambiguous figure as food? Do we perceive people we admire as being taller? In general, motivational factors can cause us to perceive what we need or want.

One of the first evaluations of the effect of motivation on perception was carried out by R.N. Sanford (1935), who studied the effect of hunger on the perception of ambiguous figures. Sanford presented figures to 10 children both before and after they had eaten. In each case he asked the children what the figures looked like. The children responded that the figures looked like food twice as often before they had eaten as after.

Children commonly perceive their parents to be larger than other people and adults show similar distortions when they estimate the size of people. Apparently, bigger is better. People with more status or value are judged to be taller. For example, Kassajarjian questioned California residents prior to the 1960 presidential election about how they intended to vote. They were also asked which of the candidates, Kennedy was ½ inch taller than Nixon, Nixon supporters was them as being about the same height, while Kennedy supporters overwhelmingly believed that Kennedy was taller. Apparently, children are not alone in overestimating the size of people they admire.

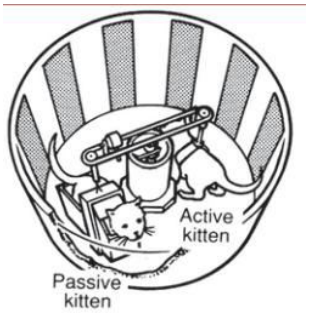
Are things of greater value generally perceived to be larger? In an attempt to answer this question, Baker, Rierden, & Wapner asked people to compare to size of coins to the size of valueless metal discs. The researcher found that people judged the coins, considered valuable, to be larger than the plain metal discs. Furthermore, the more valuable the coins, the greater the overestimation-the size overestimate of the half dollar was usually greater than the overestimate of the quarter.

D.3.3 Early Experience

Another factor that affects interpretation is early experience. Evidence from both humans and animals indicates that sensory experience in early life can alter the way an organism perceives the world.

Most Western people have slightly better acuity for horizontal and vertical lines than they do for lines oriented at an angle. One hypothesis to explain this is that Westerners have grown up in a carpentered environment of man-made objects such as buildings and roads with horizontal and vertical lines and right angles. Thus our experience with these stimuli could actually sharpen our perception of them. To test this hypothesis, Robert Annis and Barrie Frost (1973) checked perceptual acuity in a group of Canadian Cree Indians who live in a non-carpentered environment consisting of summer tents and winter lodges with lines of all different orientations. They found that the acuity of these Indians was about the same for lines of all orientations. This suggested that the differences in visual acuity between the Canadian Cree and other Westerners may be due to early visual experience.

The most convincing evidence for the effects to early experience on perception comes from studies on animals. These studies show that early visual experience not only alters perception but can also alter the brain's visual centers. In one experiment, kittens were raised in vertically striped tubes like the one shown in fig.



After five months of this type of rearing, the kitten's vision was tested. The most significant findings was that the kittens were insensitive to horizontal lines. When the experimenters held a rod in a vertical position and shook it, the kittens tried to play with it. But when they shook the rod in the horizontal position, the kittens completely ignored it. The experimenters also recorded neural activity from the kitten's visual cortex using a procedure similar to the Hubel and Wiesel procedure described earlier. They found that many of the cortical cells were sensitive to lines with a vertical orientation but that none responsive to horizontal lines (Blakemore & Cooper). Since this experiment, many other studies

have also shown that perceptual ability is directly related to the environment in which an organism is raised (Blakemore; Pettigrew).

Do humans show the same effects of early visual experience on perception? The answer to this question comes from people who have as astigmatism early in life due to a distortion in the shape of their eye. This results in an image that is out of focus in either the horizontal or vertical dimension. Thus, a person who has astigmatism sees an environment that is in focus for lines of one orientation for example, vertical lines may be clear, but horizontal lines may be blurry. In many respects they are like the kittens raised in an environment with only vertical lines.

To evaluate the effects of these early astigmatisms, researchers determined how well the individuals could see horizontal and vertical lines after their vision had been optically corrected. Even with their vision corrected these people still saw the vertical lines clearly but saw blurs in the horizontal lines. This finding suggests that, much like the kittens, abnormal vision early in life had a permanent effect on the brain and consequently on perception (Mitchell & Wilkenson).

D.3.3.1 PERCEPTUAL DEFENCE

Not only do absolute thresholds vary from person to person, they also vary from time to time for a single person. The type of stimulus, the state of one's nervous system, and the costs of false "detections" all make a difference. Emotional factors are also important. Unpleasant stimuli, for example, may raise the threshold for recognition. This effect is called perceptual defense.

The idea of perceptual defense proposes that there are times when a person actually does not perceive specific sensory input, such as a swear word or a vulgar image, presumably because she/he has a filtering mechanism or "perceptual wall" preventing the sensory data from being processed. "Dirty" words took longer to recognize when flashed on a screen that did "clean" words. Apparently it is possible to process information on more than one level and to resist information that causes anxiety, discomfort, or embarrassment (Dember & Warm, 1979).

In other words, the tendency of perceivers to protect themselves against ideas, objects, or people that are threatening to them is called perceptual defence. It is a function of selective perception which protects the individual from threatening or contradictory stimuli". "Perceptual defence occurs when a person's value orientations act as a barrier to stimuli that are threatening" (Runyon).

The perceptual defense theory does not hold up for most psychologists. In a study conducted to test perceptual defense, individuals were asked to identify a series of four-letter words flashed from a computer screen. Some of them were swearing words, some were not. Participants were asked to report the words they saw to the experimenter. The "bad words" had to be shown for longer or repeated often before they were reported. Initially, this finding was interpreted as evidence for perceptual defense.

In a later study, however, when participants were notified that there were some offensive words in the series and that it was acceptable to name these words as well, they reported seeing the offensive words with far greater frequency than in the initial study. This finding suggests that response bias provides a more likely explanation for not reporting (or delayed reporting) the offensive words in the first study. It is likely that participants' social recognition that, unless you are certain, some words are not appropriate to say in an unfamiliar public setting (i.e., a lab). In short, "perceptual defense" may be based on nothing more than peoples' recognition of social convention, more or less along the lines that follow:

Ahhh! That may be a swear word!

If I say that word, I might offend someone...

Maybe I imagined seeing the word...

I don't want the experimenter to think I'm weird if I imagined it...

I won't say it unless I see it again.

And again.

And maybe once more after that.

Finally, the concept of perceptual defense presents us with a real logical problem: how could observers know to defend themselves against a particular stimulus unless they had already perceived it? In short, there is little empirical support currently for the notion that we can defend ourselves against perceptions that we don't care for.

D.4 Culture and Perception

Several psychologists have studied the processes of perception in different socio-cultural settings. The questions they try to answer through these studies are: Does perceptual organisation of people living in different cultural settings take place in a uniform manner? Are the perceptual processes universal, or they vary across different cultural settings? Because we know, people living in different parts of the world look different; many psychologists hold the view that their ways of perceiving the world must be different in some respects. Let us examine some studies relating to perception of illusion figures and other pictorial materials.

● Sinha and Mishra have carried out several studies on pictorial perception using a variety of pictures with people from diverse cultural settings, such as hunters and gatherers living in forests, agriculturists living in villages, and people employed and living in cities. Their studies indicate that interpretation of pictures is strongly related to cultural experiences of people. While people in general can recognise familiar objects in pictures, those less exposed to pictures have difficulty in the interpretation of actions or events depicted in them.

● Rivers compared English adults and children with adult and child Murray Islanders (a group of islands between New Guinea and Australia) using the Müller–Lyer and the horizontal–vertical illusions. The Murray Islanders were less susceptible to the Müller–Lyer illusion than their English counterparts, but more susceptible to the horizontal–vertical illusion. This conclusion has been confirmed in several studies. It suggests that the habits of perception are learnt differently in different cultural settings.

● Allport and Pettigrew used the rotating trapezoid illusion. This is a trapezoid with horizontal and vertical bars attached to it, to give the impression of a window.

When attached to a motor and revolved in a circle, most western observers report seeing a rectangle oscillating backwards and forwards, rather than a trapezoid rotating through 360º (which it actually is). Allport and Pettigrew reasoned that for people unfamiliar with windows (at least as people from western cultures know them), the illusion wouldn't be perceived. When the trapezoid was viewed with both eyes and from a short distance, Zulus (who live in a rather 'circular environment') were less likely than either urban Zulus or Europeans to perceive an oscillating rectangle, and more likely to perceive a rotating trapezoid.

● Segallet al. (1963) used the Müller–Lyer illusion with members of African and Filipino cultures. Compared with white South Africans and Americans, the Africans and Filipinos were much less

susceptible to the illusion. But on the horizontal–vertical illusion, members of two African cultures (the Batoro and the Bayankole) were most susceptible. People of these cultures live in high, open country where vertical objects are important focal points used to estimate distances. For example, when a tree or pole falls away from you, it seems to grow shorter (foreshortening), but when it falls to the left or right across your field of vision its length doesn't appear to change (Price and Crapo, 1999). The Bete, who live in a dense jungle environment, were least likely of all groups tested to see the illusion. The white South Africans and Americans fell between the extremes of the three African cultures.

● Stewart used the Ames distorted room with rural and urban Tongan children. The rural children were less likely to see the illusion than those living in urban environments and European children. This was also true for other illusions, including the Müller–Lyer.

● The BaMbuti pygmies live in the dense rainforests of the Congo, a closed-in world without open spaces. When a BaMbuti archer was taken to a vast plain and shown a herd of buffalo grazing in the distance, he claimed he'd never seen such insects before. When informed that the 'insects' were buffalo, the archer was offended. They then rode in a jeep towards the buffalo. The sight of the buffalo in the distance was so far removed from the archer's experience that he was convinced Turnbull was using magic to deceive him. The archer lacked experience with distance cues, preventing him from relating distance to size (Price and Crapo, 1999).

In summary, perception is not an automatic process by which arrays of lights and sounds are mechanically turned into mental images. Instead, it is complex phenomenon by which we actively interpret the stimuli around us. As many examples in this section have demonstrated, two people may look at the same stimulus and perceive in differently. The perception is influenced by a variety of factors including what we expect to see– perceptual set; the other stimuli present – perceptual context; our needs and desires – motivational factors; and even our early experience. It is the complexity of the perceptual process that makes it such an important and intriguing subject.

D.5 Plasticity of perception

The term plasticity refers to the modifiability, or moldability, of perception. Special situations, such as prolonged changes in sensory input, can modify the ways information is processed in generating perceptions of the world around us.

D.5.1 Visual Deprivation and plasticity

Visual deprivation is the restriction of the visual input in some fashion over a prolonged time. It is especially potent during the sensitive period for visual development. A sensitive period is the time in the early development of a person or animal during which the environment has its greatest effect on behavior or on the brain processes underlying behavior.

Riesen (1965) reared three chimps from birth to seven months of age, under three different conditions:

- Debi spent the whole time in darkness.
- Kova spent 1½ hours per day exposed to diffuse (or unpatterned) light by wearing translucent goggles; the rest of the time was spent in darkness.
- Lad was raised in normal lighting conditions.

As expected, only Debi suffered retinal damage. Lad was no different, perceptually, from any other normally reared chimp. It was Kova who was of special interest, because she was only exposed to unpatterned light (patches of different colours and brightness – not distinguishable shapes or patterns), but without suffering any retinal damage. Her perceptual development was noticeably retarded. These

experiments showed that when visually deprived animals (through special lenses) were exposed to full visual experience after their sensitive periods had passed, had great difficulty in perceiving form (Riesen). Special training and visual experience after the lenses had been removed improved their form perception somewhat, but, judging from the animals' behavioural responses to visual stimuli, it almost never became "normal". (This recovery is an example of plasticity of perception). To a greater or lesser degree, the animals' visual form perception remained permanently impaired as a result of the form vision restriction during their sensitive periods.

A few unfortunate people are born with congenital cataract, a condition in which the lenses of the eyes are clouded over; others are born with, or develop soon after birth, cloudy corneas. Either of these conditions makes form vision impossible because light cannot be focused on the retina. These people can perceive large areas of brightness, but they are blind in the sense that they have no useful detail vision. They can be helped by special training; and, in some cases, operations can correct the problem. Corneal transplants can sometimes be done to replace cloudy corneas. After the operation, light can be focused on the retina and the eyes are ready for normal sight.

Case study of S.B. (Gregory & Wallace, 1963)

● S.B. was 52 when he received his sight after a corneal graft operation.

● His judgement of size and distance was good, provided he was familiar with the objects in question.

● Unlike most of the cases studied by Hebb, he could recognise objects visually if he was already familiar with them through touch (he displayed good cross-modal transfer). However, he seemed to have great difficulty in identifying objects visually if he wasn't already familiar with them in this way. A year after his operation, he still couldn't draw the front of a bus, although the rest of the drawing was very well executed.

● As the months passed, it became clear that S.B. was in some ways like a newborn baby when it came to recognizing objects and events by sight alone. For instance, he found it impossible to judge distances by sight alone. He knew what windows were, but, of course, he'd never been able to look out from a top-floor window, and he thought 'he would be able to touch the ground below the window with his feet if he lowered himself by his hands'. The window in question was the one in his hospital room – 40 feet above the ground!

● He never learned to interpret facial expressions such as smiles and frowns, although he could infer a person's mood from the sound of their voice. He preferred to sit in the dark all evening, instead of putting on the light.

Figure: This was drawn after S.B. had had some experience of sighted travel. Basically it shows the parts he knew by touch but clearly he had also, by this time, noticed the bright advertisement for Typhoo Tea on the side of the bus.

When the bandages come off after the operation, these patients can visually recognize objects that were familiar to them through their other senses. However, they have great difficulty whith visual recognition of new objects. For example, faces and letters are hard for them to recognize, and their perception may never be normal for these new objects. But as these patients visually experience the environment, their perception gradually becomes more normal, and this recovery is another example of plasticity of perception. The amount of recovery depends upon many factors, and some people make more progress than others. Even in the best cases, however, perception probably never becomes normal. In fact, some patients, after a period of using their new vision, go back to relying on the sensory channels they used when blind. (Gregory).

Instead of eliminating all form vision, a number of researchers have restricted the visual environment of animals to a few specific kinds of visual input, or features, during their sensitive periods. Blakemore and Cooper (1970) raised kittens from birth in darkness, except for a five-hour period each day when they were placed in a large round chamber. This had either vertical or horizontal stripes painted on the inside, and a glass floor that reflected the pattern of stripes. The kittens wore special collars which prevented them from seeing their own bodies; the stripes were the only visual stimuli they encountered.

At five months old, the kittens were tested for line recognition by being presented with a moving pointer held either vertically or horizontally. Those reared in the 'vertical world' would reach out only to a vertical pointer, while those raised in the 'horizontal world' reached only for a horizontal pointer. Depending on their early visual experience, the kittens acted as if they were blind in the presence of the other kind of visual stimulus. This 'behavioural blindness' mirrors 'physiological blindness'. By placing microelectrodes into individual cells in the visual cortex, Blakemore and Cooper found that the 'vertical' kittens didn't possess cells that were responsive to bars of light moved horizontally, and the reverse was true for the 'horizontal' kittens. The only receptive fields to have developed were those that reflected the kittens' early visual experience, the kittens acted as if they were blind in the presence of the other kind of visual stimulus. With some exceptions, these studies show that the responses of cells in the visual brain are altered in specific ways that relate to the visual features to which the developing animal is exposed during the sensitive period. And some experiments have been able to relate the brain changes to changes in perception by means of behavioural tests (Blasdel et al). Thus plastic changes in perception, as indicated by behavior have been matched with plastic changes in the brain.

Experiment: Turning the world upside down (Stratton)

- Stratton fitted himself with a telescope on one eye which 'turned the world upside down'. The other eye was kept covered. He wore the telescope for a total of 87 hours over an eight-day period, wearing blindfolds at night and at other times when not wearing the inverting lens. As far as possible, Stratton went about his normal routine.
- For the first three days, he was aware that part of his environment – the part not in his immediate field of vision, but on the periphery – was in a different orientation.
- But by day four, he was beginning to imagine unseen parts as also being inverted, and by day five he had to make a conscious effort to remember that he actually had the telescope on. He could walk round the house without bumping into furniture, and when he moved his surroundings looked 'normal'. However, when he concentrated hard and remained still, things still appeared upside down.
- By day eight, everything seemed 'harmonious'; he began to 'feel' inverted, but this was quite normal and natural to him
- When Stratton removed the telescope, he immediately recognised the visual orientation as the

one that existed before the experiment began. He found it surprisingly bewildering, although definitely not upside down. This absence of an inverted after-image/ after-effect means that Stratton hadn't actually learnt to see the world in an upside-down fashion.

E. Subliminal Perception

Subliminal perception occurs whenever stimuli presented below the threshold or limen for awareness is found to influence thoughts, feelings, or actions. The term subliminal perception was originally used to describe situations in which weak stimuli were perceived without awareness. In recent years, the term has been applied more generally to describe any situation in which unnoticed stimuli are perceived.

The concept of subliminal perception is of considerable interest because it suggests that peoples' thoughts, feelings and actions are influenced by stimuli that are perceived without any awareness of perceiving. This interest was reflected in some of the earliest psychological studies conducted during the late 1800s and early 1900s. In these early studies, people were simply asked whether or not they were aware of perceiving. For example, visual stimuli such as letters, digits, or geometric figures were presented at such a distance from observers that they claimed either not to see anything at all or to see nothing more than blurred dots. Likewise, auditory stimuli such as the names of letters were whispered so faintly that observers claimed that they were unable to hear any sound whatsoever. To test whether these visual or auditory stimuli may have been perceived despite the statements to the contrary, the observers were asked to make guesses regarding the stimuli. In other words, despite the observers' statements indicating that they were unaware of perceiving the stimuli, their guesses indicated that they did in fact perceive sufficient information to make accurate guesses regarding the stimuli. Over the years, there have been literally hundreds of studies following a similar format. Taken together, these studies show that considerable information capable of informing decisions and guiding actions is perceived even when observers do not experience any awareness of perceiving.

Another way in which subliminal perception has been demonstrated in controlled laboratory studies is by showing that stimuli can be perceived even when they are presented under conditions that make it difficult if not impossible to distinguish one stimulus from another stimulus. The classic studies were conducted in the 1970s by the British psychologist Anthony Marcel. These experiments were based on previous findings indicating that a decision regarding a stimulus is facilitated or primed when the stimulus follows a related stimulus. For example, if an observer is asked to classify a letter string as either a word (e.g., doctor, bread) or a nonword (e.g., tocdor, dreab), a letter string such as the word doctor will be classified as a word faster when it follows a semantically related word (e.g., nurse) than when it follows a semantically non-related word (e.g., butter). Marcel found that words facilitated or primed subsequent word/nonword decisions to letter strings even when the words were presented under conditions that made it difficult if not impossible for the observers to distinguish when the words were present from when the words were absent. Since the time of Marcel's original experiments, there have been many other studies that have used similar methods. Not only have these studies confirmed Marcel's original findings, but they have shown that other stimuli such as pictures, faces, and spoken words can also facilitate subsequent decisions when they are presented under conditions that make it difficult to discriminate one stimulus from another stimulus. Although questions have been raised regarding whether the observers in these studies were completely unable to discriminate one stimulus from another stimulus, the one firm conclusion that can be made on the basis of these studies is that considerable information is perceived even when observers experience little or no awareness of perceiving as indicated by their difficulty in discriminating one stimulus from another stimulus.

Examples of subliminal perception are found in studies of patients with neurological damage. A striking characteristic of a number of neurological syndromes is that patients claim not to see particular stimuli but nevertheless respond on the basis of information conveyed by these stimuli. One example is a syndrome called blindsight. Patients with blindsight have damage to the primary visual cortex. As a result of this damage, they are often unaware of perceiving stimuli within a restricted area of their visual field. For example, if the visual field is thought of as consisting of four quadrants, a blindsight patient may have normal vision for stimuli presented in three of the quadrants but be completely unaware of stimuli presented in the fourth quadrant. However, even though these patients may claim not to see stimuli located within the "blind" quadrant, they are still able to guess the size, shape or orientation of the stimuli that they claim not to see. Another neurological syndrome in which subliminal perception occurs is prosopagnosia or face agnosia. Patients with prosopagnosia are unable to recognize familiar faces. Although they may be aware that they are looking at a person's face, they are unable to say who the person may be. Thus, prosapagnosics have no awareness of perceiving any information regarding whose face they may be viewing. However, despite this absence of awareness, some patients with prosapagnosia are able to choose which of two names goes with each familiar face that they claim not to be able to recognize.

Perception without awareness of perceiving can also occur in surgical patients undergoing general anesthesia. One goal of general anesthesia is to ensure that surgical patients are completely unaware of all events that occur during anesthesia. This goal is satisfied in the vast majority of cases because when patients are asked following surgery to report anything they remember that happened during surgery, just about every patient claims not to remember anything. However, when memory is assessed by more indirect methods, there appears to be some memory for events during anesthesia. For example, during surgery, patients may wear earphones and a tape recording of a number of repetitions of a series of words may be played to the patients. If following surgery, these patients are presented word stems such as gui _ _ or pro _ _ and asked to complete these stems to produce a common English word, there are numerous possible completions (e.g., guilt, guild, guile; prove, prowl, probe). However, if the words guide and proud had been presented during anesthesia, then the patients may be more likely to complete the stems gui _ _ and pro _ _ with letters that reproduce guide and proud than with letters that produce other possible words. Given that patients undergoing general anesthesia are unaware of events in the external environment, memory for specific stimuli presented during anesthesia shows that information is at times perceived without any awareness of perceiving during general anesthesia.

Over the years, some extraordinary claims have been made concerning the power of subliminal perception. Perhaps the most widely known claim was made in 1957 by James Vicary, a market researcher. He claimed that over a six-week period, 45,699 patrons at a movie theater in Fort Lee, New Jersey were shown two advertising messages, Eat Popcorn and Drink Coca-Cola, while they watched the film Picnic. According to Vicary, a message was flashed for 3/1000 of a second once every five seconds. The duration of the messages was so short that they were never consciously perceived. Despite the fact that the customers were not aware of perceiving the messages, Vicary claimed that over the six-week period the sales of popcorn rose 57.7% and the sales of Coca-Cola rose 18.1%. Vicary's claims are often accepted as established facts. However, Vicary never released a detailed description of his study and there has never been any independent evidence to support his claims. Also, in an interview with Advertising Age in 1962, Vicary stated that the original study was a fabrication. The weight of the evidence suggests that it was indeed a fabrication.

Other claims regarding the extraordinary efficacy of subliminal perception also lack substance. In the 1970s, Wilson Bryan Key wrote such books as Subliminal Seduction and Media Sexploitation in which he claimed subliminal sexual symbols or objects are often used to entice consumers to buy and use various

products and services. One of Key's most famous claims is that the word sex was often embedded in products and advertisements. For example, he claimed that the word sex was printed on Ritz crackers and was embedded in the ice cubes of the drink shown in a well-known ad for Gilbey's Gin. According to Key, despite the fact the embedded words are not consciously perceived, they are unconsciously perceived and can elicit sexual arousal which in turn makes the products more attractive to consumers. Although Key's claims are widely known, there is no independent evidence indicating that embedded subliminal words, symbols, or objects are used to sell products. Furthermore, even if such embedded subliminal stimuli were used, there is no evidence to suggest this would be an effective method for influencing the choices that consumers make.

Belief in the power of subliminal perception to induce changes in the way people feel and act is so widespread that a number of companies have been able to exploit this belief by marketing subliminal self-help audio and video tapes. The companies that market these tapes claim that regular use of the tapes can cure a variety of problems and aid in the development of many skills. Each company markets a number of different tapes. Presumably, what distinguishes the different tapes marketed by each company are the embedded subliminal messages that can be neither consciously seen or heard. Some of the more popular tapes are claimed to help individuals stop smoking, lose weight, or reduce stress; other tapes are claimed to help people increase their reading speed, improve their memory, or develop their skills at tennis (or golf or baseball, etc.). Given the extraordinary nature of these claims, there have been a number of controlled studies designed specifically to test of the efficacy of the tapes. All of these studies have failed to find any evidence consistent with the claims of the companies that market these tapes. There is simply no evidence that regular listening to subliminal audio self-help tapes or regular viewing of subliminal video self-help tapes is an effective method for overcoming problems or improving skills. In fact, there is even evidence to suggest that many subliminal self-help tapes do not even contain subliminal messages that could possibly be perceived under any circumstances by a human observer.

A common theme that links all extraordinary claims regarding subliminal perception is that perception in the absence of an awareness of perceiving is somehow more powerful or influential than perception that is accompanied by an awareness of perceiving. This idea is not supported by the results of controlled laboratory investigations of subliminal perception. Rather, the findings from controlled studies indicate that subliminal perception, when it occurs, reflects a person's usual interpretations of stimuli. Furthermore, there is no evidence to suggest that people initiate actions on the basis of subliminal perception. The weight of the evidence indicates that people must be aware of perceiving stimuli before they initiate actions or change their habitual reactions to these stimuli. Thus, although subliminal perception may allow us to make accurate guesses regarding the characteristics of stimuli, subliminal perception cannot lead a person to drink Coca-Cola or to eat Ritz Crackers.

F. Extrasensory Perception

Most psychologists believe that the sensory systems or modalities described earlier are the only means by which we can acquire information about our environment (both physical objects and other people). However, there are some phenomena that seem to involve meaningful exchanges of information between organisms and their environment, and yet at the same time appear somehow to exceed the capacities of the sensory and motor systems as they are currently understood (Rao and Palmer, 1987).

For these reasons, such phenomena are considered to be anomalous; they include what's commonly referred to as paranormal phenomena (or psi, short for 'psychic ability'), the subject matter of parapsychology.

Such phenomena include extrasensory perception (ESP). The term unambiguously implies that there are ways of acquiring information about the world that don't depend on vision, hearing and so on.

J.B. Rhine introduced the term 'extrasensory perception' (ESP) in 1934. This was a general term used to cover three types of communication that supposedly occur without the use of the senses, namely *telepathy*, *clairvoyance* and *precognition*.

● **Telepathy**: 'the transmission of information from one mind to another, without the use of language, body movements, or any of the known senses' (Evans). It was previously called 'thought transference'.

● **Clairvoyance**: 'the acquisition by a mind or brain of information which is not available to it by the known senses, and, most important, which is not known at the time to any other mind or brain' (Evans,).

● **Precognition**: 'the apparent ability to access information about future events before they happen' (Morris)

These are all forms of extrasensory perception (ESP). In all cases, the direction of influence is from environment to person.

Early ESP research used Zener cards, which allowed the experimenter to compare the results with what would be expected by chance (i.e. guessing). In telepathy experiments, a receiver had to guess the identity of a target symbol being looked at by an agent/sender. In clairvoyance experiments, the cards were randomised out of sight of everyone, and in precognition experiments, card order was determined only after the receiver had made his/her guesses.

Free-response methods include remote-viewing and the Ganzfeld. The so-called Ganzfeld debate between Honorton and Hyman, resulting in their joint statement identifying areas of agreement between them, brought parapsychologists and sceptics together in an effort to define an acceptable experiment. This resulted in a fully automated Ganzfeld, but the dispute between 'sheep' (those who believe in the reality of ESP) and 'goats' (those who don't) continues.

In addition to parapsychologists continually having to prove they're not cheating, several methodological issues, while not unique to PP, assume a more extreme form in relation to psi. These include the 'conclusive' experiment, the replication problem, publication bias (or the file drawer problem), the inadequacy of controls and experimenter effects.

Parapsychologists who apply 'normal' scientific methods are following a long tradition of scientists who investigated phenomena that, at the time, seemed mysterious (Utts and Josephson, 1996) or were given what we'd now consider bizarre, 'unscientific' explanations. 'Paranormal' is a convenient label for certain aspects of human behaviour and experience that can be investigated scientifically and are subject to 'scientific' explanation. Once they've been accounted for scientifically, they'll no longer be called 'paranormal'

However, if psi 'really exists', what does this imply for many of our fundamental scientific beliefs about the world? While strong opposition to PP is understandable, prejudgements about the impossibility of psi are inappropriate in science. Many psychologists who aren't yet convinced that psi has been demonstrated are nevertheless open to the possibility that new evidence may emerge that would be more compelling.